EXPERIMENTAL ELECTRIC MOOSE FENCE STUDY

Measures to Reduce Moose-Vehicle Collisions in Northeast New Brunswick

2000 - 2003

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EXECUTIVE SUMMARY

Moose-vehicle collisions have been an escalating problem along highway corridors throughout New Brunswick in recent years. As moose populations have gradually grown and highway systems improved, the number of moose-vehicle collisions now exceeds 250 annually. These collisions often result in property damage, human injuries, and occasionally human deaths. In addition, a substantial number of moose are killed or injured each year due to vehicle collisions, resulting in an important recreational and economic loss.

In the fall of 1999, the New Brunswick Ministers of Transportation and Natural Resources asked their representatives to meet with a group of concerned citizens in Belledune, New Brunswick, to review the problems with moose-vehicle collisions along Routes 8 and 11 in northeastern New Brunswick, and explore possible solutions. Following an initial meeting in January 2000, the Northeast New Brunswick Moose-Collision Working Group was established consisting of concerned citizens and government representatives. The goal of this group was to find practical and cost effective approaches to reduce moose-vehicle collisions along New Brunswick highways, with particular emphasis on Route 11. Following a thorough review of scientific literature and various projects and approaches used throughout North America, the Working Group developed four possible practical solutions worth investigating: digital warning signage, highway lighting, electric fencing, and comprehensive public awareness.

In the summer of 2000, the NB Government approved implementation of a study to be conducted near Belledune using ElectroBraid electric fencing and sanctioned the development of a comprehensive public awareness program to help reduce moose-vehicle collisions in the Province. This report details the findings of these two initiatives following the 3-year time frame that was approved [2001-2003].

The key results and recommendations were:

1. There was high interest and participation by the motoring public during the 3 years. More than 400 reports of moose and other wildlife activity were received annually.
2. The costs of the electric fence was approximately $12,000 per kilometer plus annual maintenance costs, compared to more than $70,000 per kilometer plus maintenance for standard wildlife fencing.
3. The number of moose sightings in the electric fence zone was significantly lower than the two control zones for each year of the study.
4. One moose-vehicle collision occurred within the fence zone, compared to 4 moose and 2 deer reported killed within the two control zones.
5. This study was the first application in North America of an electric fence designed to deter moose along a linear highway system. This type of fencing is now being employed in Quebec and several states in USA.
6. It was recommended to continue monitoring the fence in Belledune for 2004 and 2005 to provide a better comparison with the previous 5 year moose-vehicle collision data, in order to draw a more conclusive assessment of the electric fence.
7. DOT should consider electric fencing as an option in other parts of New Brunswick where relatively short sections of highway bisect high-density moose range.
8. A province-wide monitoring system for moose sightings along highway corridors should be considered to identify chronic and developing wildlife-vehicle collision risk areas.
9. Efforts should be continued to maintain public awareness of the risks of moose-vehicle collisions throughout New Brunswick, and precautions that motorists could take to avoid collisions.
10. Efforts should be continued to liaise with other jurisdictions, to keep abreast of new technologies, tools and approaches that may assist New Brunswick in reducing moose-vehicle collisions.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES [continued]

Figure **Page**

BACKGROUND

The Moose-Vehicle Collision Committee and Working Group were established as a result of a meeting convened on 20 January 2000 at the Recreation & Culture Centre, Belledune, NB. Thirty-three persons were in attendance at this inaugural meeting including representatives from NB Department of Transportation [DOT] and NB Department of Natural Resources [DNR]. The objectives were to exchange and share information regarding moose-vehicle collisions in the Campbellton to Miramichi corridor along Route 11 and Route 8 and to examine possible solutions.

Representatives from DOT and DNR presented recent moose-vehicle collision data for the section of Route 11 between Campbellton and Bathurst. Several regions throughout New Brunswick have been designated as high potential for moose-vehicle collisions, with the northeast being particularly dangerous for motorists and moose [Figure 1]. Generally, it was agreed that moose-vehicle collisions were a problem along Route 11.

A wide range of ideas and possible solutions were discussed at the inaugural meeting. Proposed solutions included reducing highway speeds, better signage, improved lighting of highways, installation of game-proof fencing, increasing hunter harvests of moose, encouraging installation of "wildlife whistles" on vehicles, installation of Swareflex reflectors, brushing back vegetation along the highway corridor, applying wolf urine along problem routes, and patrolling highways and tranquilizing/removing moose or deploying rubber bullets as deterrents.

Although most participants considered fencing and/or highway lighting could be effective solutions at specific locations, the evidence available along Route 11 showed that problem areas shift

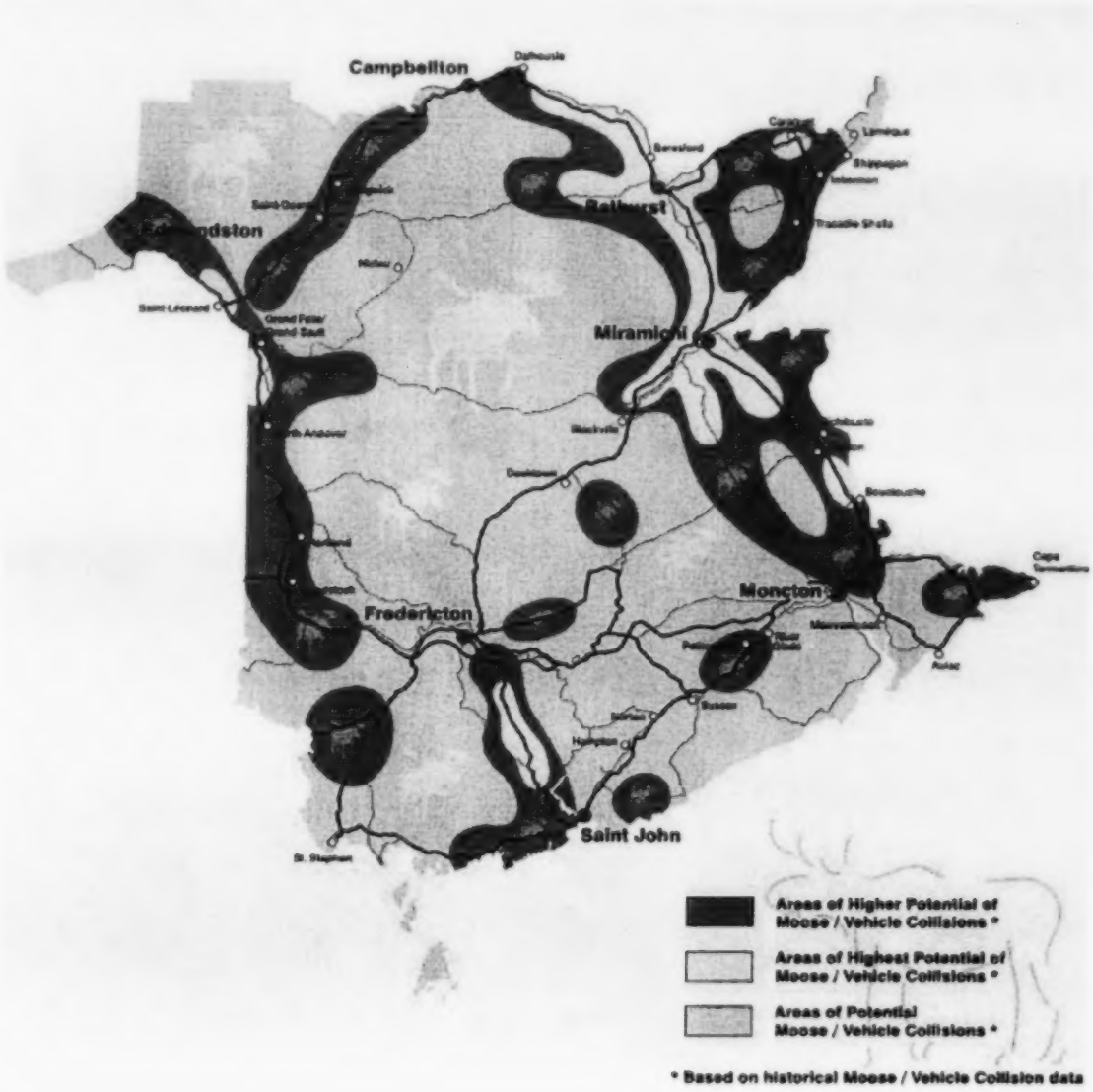

Figure 1. Areas of New Brunswick designated as potentially high-risk for moose-vehicle collisions based upon historical wildlife collision information from NB Department of Transportation and NB Department of Natural Resources records.

from year-to-year so that it would neither be feasible nor cost-effective to fence or light the entire corridor. Most attendees appreciated the fact that the moose-vehicle collisions have been human-

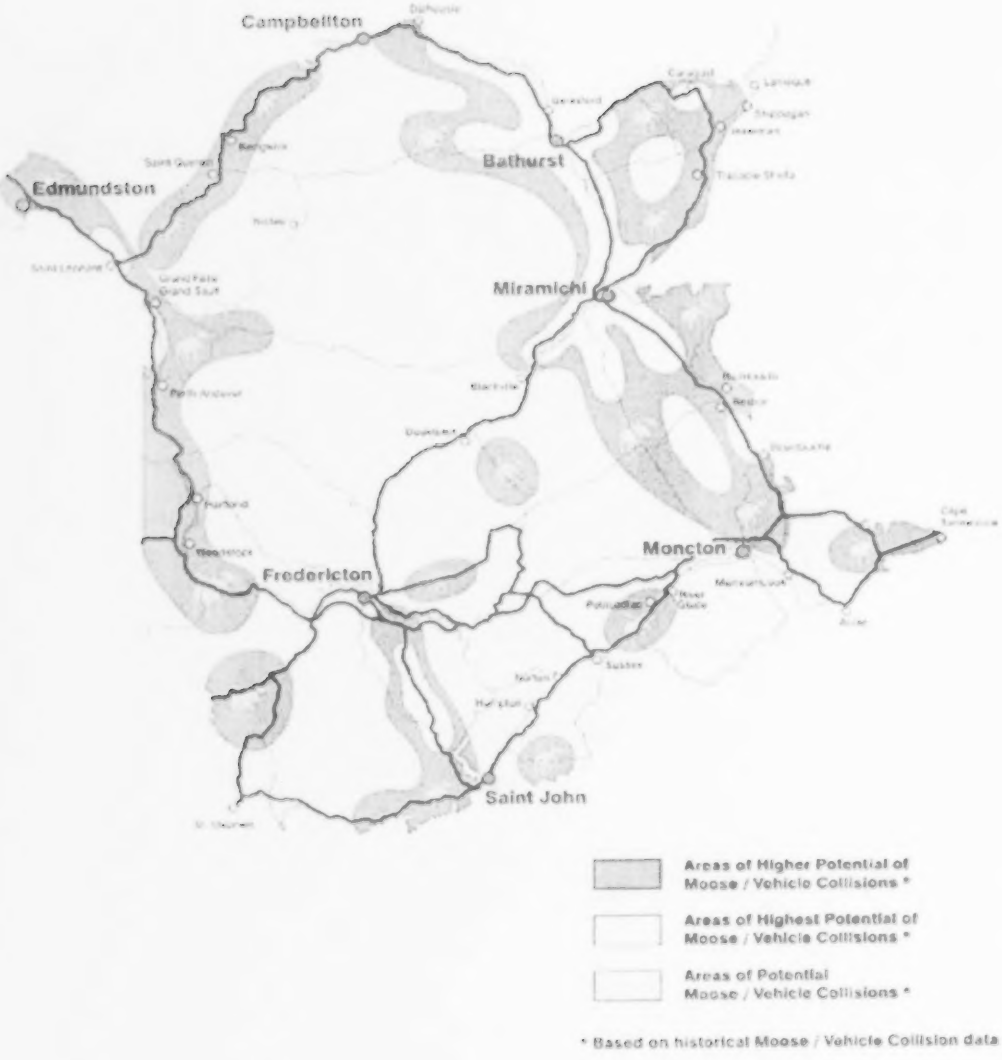

Figure 1. Areas of New Brunswick designated as potentially high-risk for moose-vehicle collisions based upon historical wildlife collision information from NB Department of Transportation and NB Department of Natural Resources records.

from year-to-year so that it would neither be feasible nor cost-effective to fence or light the entire corridor. Most attendees appreciated the fact that the moose-vehicle collisions have been human-

induced because highways often have been constructed through prime moose habitat. Many felt that public education and awareness would be a key component of any practical solutions towards reducing moose-vehicle collisions along this corridor.

At the conclusion of the inaugural meeting, The Northeast New Brunswick Moose-Vehicle Collision Working Group [hereafter referred to as the Working Group] was established that included representation from Government, industry, and concerned community residents [Appendix I]. The Working Group met regularly in 2000 and scoped-out in more detail specific issues associated with this highway corridor and possible solutions to moose-vehicle collisions.

After considerable discussion of numerous ideas, the Working Group narrowed their focus and efforts to the following four approaches as possible practical solutions worthy of further attention:

1. Deploying portable digital warning signage near problem areas and devising a mechanism for activating and de-activating these signs in response to moose activity along the highway;
2. Determining the effectiveness of lighting along a known, problem section of highway as a method of reducing moose-vehicle collisions;
3. Testing a new type of portable electric fencing [ElectroBraid] that showed promise as a deterrent to wildlife movement; and
4. Developing and implementing a comprehensive public awareness project that targeted motorists traveling throughout New Brunswick.

A detailed review of moose-vehicle collision data along Route 8 and Route 11 between Campbellton and Miramichi resulted in the proposal of three [3] pilot moose-vehicle accident

mitigation projects at the following locations:

1. Mobile digital signage was recommended for testing along a 17 km section of Route 8 between the Allardville intersection and Bathurst city limits [Figure 2]. Estimated costs of digital signage ranged from $25,000 to $76,000 each depending upon the type and features chosen. Approximately 4 to 6 signs would be necessary to adequately cover this 17 km section.
2. Standard street lighting was proposed for examination along a 6.5 km section of Route 8 between the intersection of Route 450 [Doyles] and Big Eskedelloc [Figure 2]. Estimated costs of regular light standards ranged between $30,000 and $50,000 per kilometer.
3. Portable electric fencing along both sides of a 5 km section of Route 11 between Belledune [Turgeon Exit] and the Belledune River [NB Power Dam] was proposed for field testing [Figures 2]. It was estimated that costs would be approximately $10,000 per kilometer. Representatives from ElectroBraid Fence Limited of Halifax, Nova Scotia expressed interest in cooperating with the Working Group to supply, install, and maintain the fence on an experimental basis and to recover costs of materials pro-rated over a 3-year period.

In addition to these specific proposed pilot projects, the Working Group planned to develop a comprehensive public awareness program outlining the dangers of moose-vehicle collisions along this route as well as elsewhere in New Brunswick. Initial plans included developing brochures for tourists and other motorists, posters, public service announcements, videos, highway signage at strategic locations along Routes 11 and 8, and working with schools, businesses, insurance companies and service clubs in an effort to promote awareness of the dangers to motorists of moose along this route.

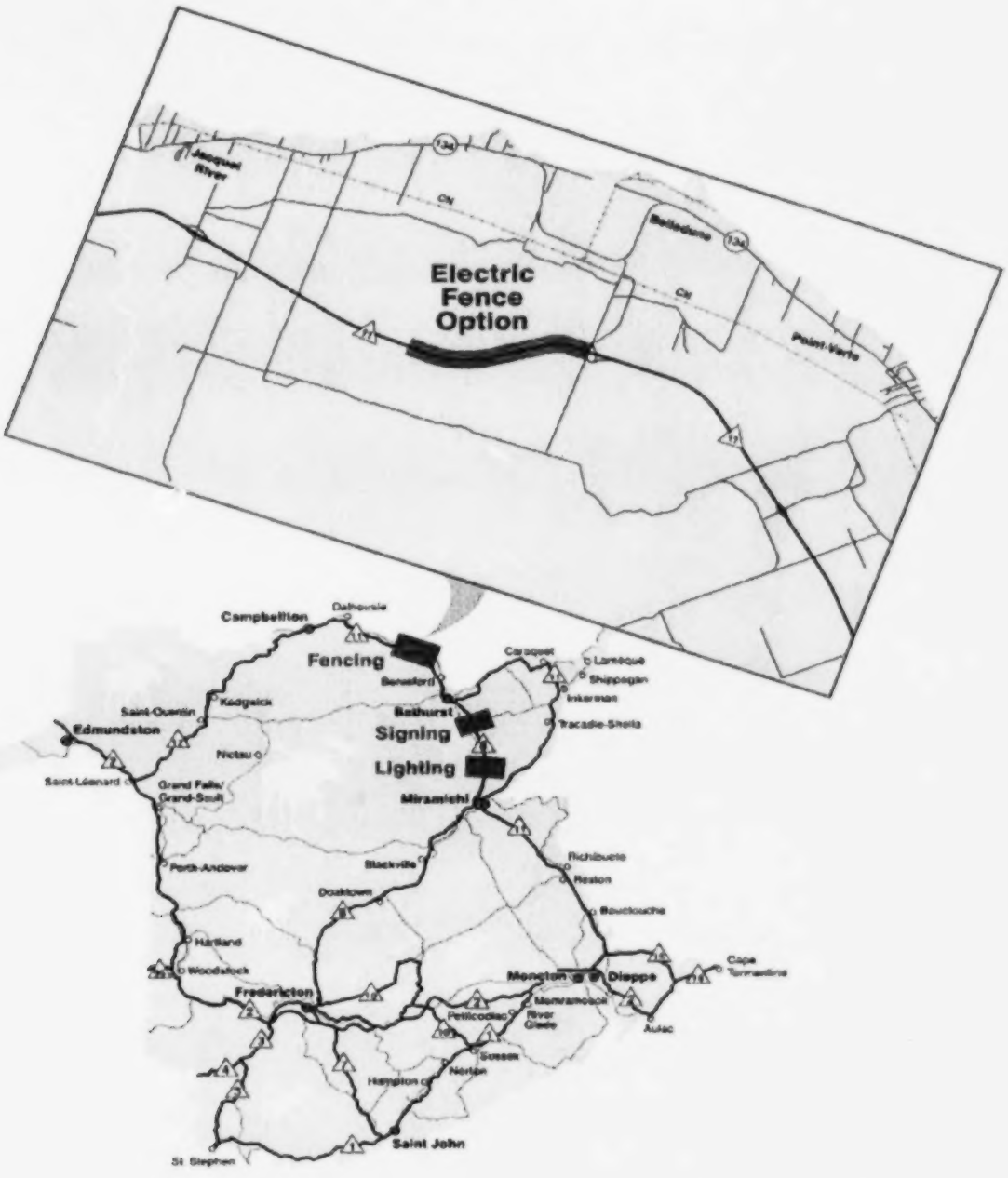

Figure 2. Proposed locations of mobile digital signage and standard street lighting projects [Route 8] and electric fence study [Route 11] for mitigating moose-vehicle collisions in northeast New Brunswick.

Given the costs and logistical complexities associated with each of these proposals, the Working Group decided to focus their immediate efforts in two areas:

- Electric moose fencing project
- Public awareness of moose-vehicle collisions in New Brunswick

A comprehensive public awareness strategy was considered to be a crucial element for all of the proposed mitigation projects. The electric fencing project had an advantage over the other two proposals because of overall lower projected costs and the desire by a private company to partner in the experiment. In May 2000, of ElectroBraid Fence Limited, Halifax, met with the Working Group, examined the proposed project and agreed to partner in this experiment by providing fencing materials [at cost], supervision of the installation of the electric fence, and follow-up maintenance and trouble-shooting of the fence product during the field testing phase.

The remainder of this report is focused on (i) the design of the electric moose fencing experiment, (ii) the time and financial expenditures incurred in the study, (iii) the results of the fence project, (iv) public awareness initiatives, and (v) the conclusions and general recommendations derived from this 3-year study.

ELECTRIC FENCE STUDY: DESIGN

The primary objective of the project was to prevent moose-vehicle collisions within a 5 kilometer corridor fenced along both sides of the highway using electric fencing materials. Another objective was to situate the fence so that it would act as a distinct barrier to moose movement and could not be breached easily at either the east or west highway entrances. The eastern end of the fence was established at the Turgeon Exit of Route 11, an interchange that had some lighting for better night visibility by motorists. The western end of the fence was the Belledune River, where a hydro-electric dam had created a large pond that could act as a natural barrier to moose movement onto the highway and between the electric fences [Figure 3]. At both ends of the experimental section, the fence was tied-in closely to the highway guard rails to deter moose from entering the fenced highway corridor.

Initial discussions of the project design centered on issues of human and animal safety, electrical connection logistics, maintenance and repairs, snowmobile and ATV access, and monitoring the results of the experiment. In order to assess the overall success of the project, it was deemed necessary to establish control zones along Route 11 at both the eastern and western ends of the fenced area. Accurate and consistent reporting of moose sightings along the fenced and control zones were considered crucial for determining the overall effectiveness of the electric fence. Given the variability in moose-vehicle accidents recorded along Route 11 from 1996 to 2000, it was decided that a minimum of three years of monitoring would be necessary in order to obtain sufficient data to properly judge the effectiveness of the electric fence in deterring moose from the zone.

Various options were discussed with respect to experimental design for the fence project. It was important to the Working Group to attempt to maximize safety for the motoring public throughout

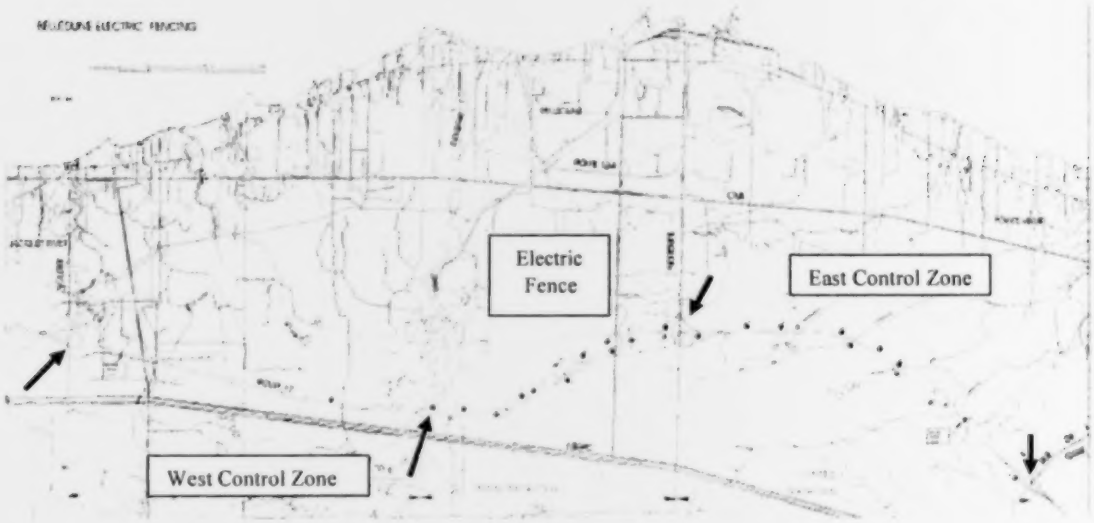

Figure 3. Location of the electric moose fence area and east and west control zones, Belledune, New Brunswick, 2000 – 2003.

all aspects of this experimental project. The following sections outline the components and rationale for the design of this study.

Location of Electric Fence - The five (5) kilometer highway corridor chosen to study the effectiveness of electric fencing was an area of prime moose habitat between the Belledune River and Turgeon Road exit [Figure 3]. This section was densely forested and included numerous streams and brooks throughout its length. This section of highway was selected for study because of the relatively high number of moose/deer-vehicle collisions that had occurred during the 5-year period 1996-2000; with the exception of 2000, one or more moose/deer collisions had occurred each year along this stretch of Route 11. An additional benefit of this location was that the western end of the fence was bounded by the Belledune River which might act as a natural barrier to the possibility of moose, deer, or bear entering the highway between the fences and getting trapped. The eastern entrance to the fence zone

was situated at the Turgeron Road exit which was considered to be a possible artificial barrier that might deter moose from entering the highway between the fences at that end of the study zone. This interchange also had standard street lighting which provided a power source for the fence and offered some night visibility for motorists to detect moose crossing the highway.

Controls - Two sections of highway were chosen as "controls"; one control zone at each end of the fenced section. The western control zone was a 6 km section of Route 11 that extended from Jacquet River [Becketville] intersection to the Belledune River [NB Power Dam] [Figure 3]. The eastern control zone was a 6.5 km section of Route 11 extending from the Pointe-Verte [Madran] exit to the Turgeon [Belledune] Road exit [Figure 3]. These control zones were well defined and easily identified by the motoring public when reporting sightings of animals along the study route.

Power Connection of Electric Fence - The electrical hardware and power requirements for 10 km of electric fencing were projected to be minimal. It was estimated that the electricity needed to operate the fence would be roughly equivalent to one or two 100 watt light bulbs. NB Power agreed to partner with this project by providing the necessary hardware components for connecting the fence to the power grid and supplying the ongoing electricity needs for the duration of the study. Figure 4 shows the location where the fence was linked to the power grid at the Turgeon Road exit. An alarm system, provided by ElectroBraid Fence Limited, was established at the power grid to detect and locate drops in voltage that might occur during the study.

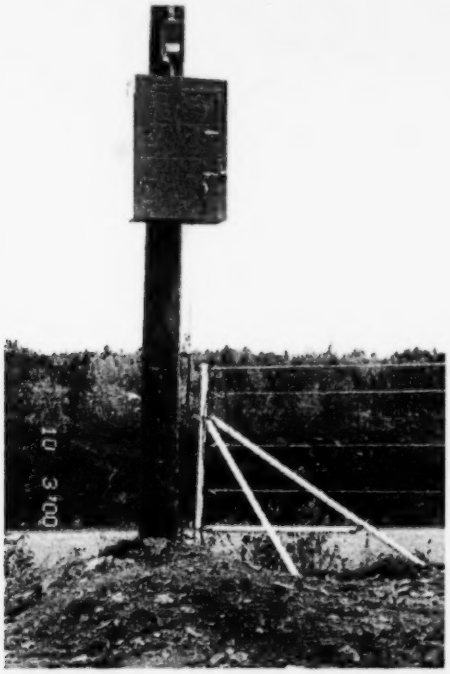

Figure 4. Location of power grid connection and alarm for the electric fence at Turgeon Road exit, Route 11, Belledune, NB.

Accommodating Access Points - Highway 11 is a Level One Access Controlled Highway which does not permit any driveway access. However, during the preliminary reconnaissance for determining the location of the electric fence, it was discovered that all-terrain vehicle [ATV] and snowmobile access would be required at one location along the fenced route. ATV and snowmobile users frequently crossed Route 11 at this location. Several options were considered to solve this problem including removing some of the fenced sections at the location of this crossing during winter [when moose were not active near the highway], installing Texas "cattle" gates at each entrance, blocking access completely, or erecting a gate that would have to be opened and closed each time access across the highway was required. Instead, it was decided to develop a type of "maze" with the electric fence

that was wide enough for ATV and snowmobile passage but presented a visual barrier to moose that would encounter the fence at this location [Figure 5].

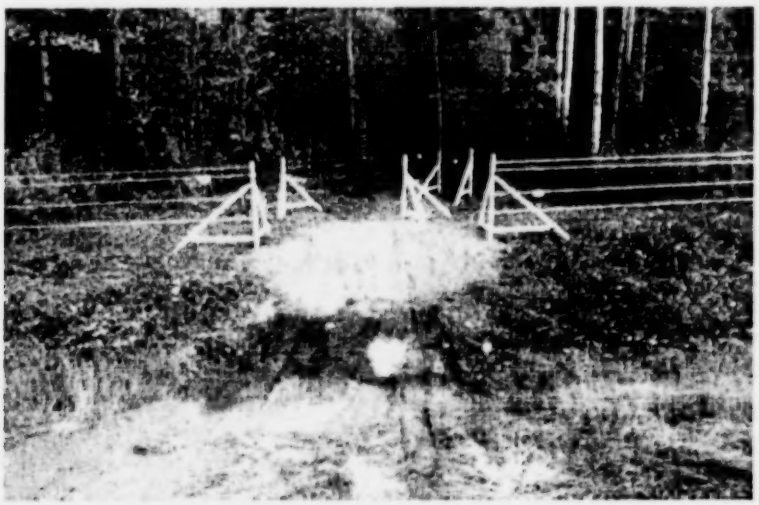

Figure 5. Snowmobile / ATV access and maze structure design [view from highway] to prevent moose and other wildlife from entering the Route 11 highway corridor, Belledune, NB.

Sand was deposited on the ground at the entrance to each maze to provide a mechanism to monitor tracks of moose and other wildlife at these openings. These locations were checked periodically to determine their effectiveness in preventing access to moose, yet still provide a suitable crossing for recreational users of the trail. In winter when moose were not occupying this area, the mazes could be temporarily straightened and widened to allow snowmobile access. The local snowmobile/ATV club was notified about the fence and maze to solicit their cooperation and assistance during the experimental study.

Highway Mileage Markers - For the public to report reliable locations of moose activity along the project route, it was considered necessary to establish visible kilometer markers along the highway. NB DOT had been planning to erect mileage markers along several highway alignments throughout New Brunswick and agreed to develop and install markers at 1-km intervals throughout the study area for this project. Figure 6 shows an example of the type of location markers used along Route 11 near Belledune, NB.

Figure 6. Mileage [kilometer] marker installed along Route 11 near Belledune NB for the purpose of obtaining from motorists precise locations of wildlife activity.

Highway Signage and Motorist Reports - It was recognized by the Working Group that the motoring public could be a cost-effective and efficient way of obtaining moose observations during this study. Relatively high traffic volumes were characteristic of Route 11 and motorists traveled this route at virtually all times of day and night. The objective was to have a mechanism for the public to quickly

and accurately report moose sightings within the study zone. With the growing use of cellular telephones by motorists, it was decided that signs could be erected that clearly identified a telephone number that could be used to report moose sightings. DOT designed and erected two large signs along Route 11, one at both approaches to the "control" zones [Figure 7]. These signs had a simple and clearly visible bilingual message: "REPORT SIGHTINGS--- RAPPORTEZ LES OBSERVATIONS 522-3777", as well as incorporated a large silhouette of a bull moose.

Figure 7. Bilingual sign identifying the telephone number that motorists could use to report moose activity at the entrance of the West Control Zone, Route 11, Belledune, NB.

NBTel [now Aliant NB] partnered on the project by providing the telephone number, hardware connections, and associated monthly service costs during the experiment. Also, it was necessary to have a person available to receive information on sightings reported by the public on a 24-hour, 7-days-per-week basis. The Village of Belledune Dispatch Service agreed to partner in this project by

providing the service of recording moose sightings reported to them by motorists via the dedicated telephone line.

Moose Observation Report - It was considered important to have consistent data collection of moose activity reported by the public to the Belledune dispatcher that received telephone calls. A moose observation report was developed for use by the dispatcher [Appendix II]. Information recorded included date and time of call, date and time that moose [or other wildlife] were actually observed, the highway and mileage marker number where the observation was made, and the precise location of the sighting including whether or not the moose were seen on the highway or on the east or west sides of the highway. Also, it was important to record whether or not the sighting was within a control or fence zone, the species, sex and number of animals observed, and the animals' behavior [running, walking, standing, feeding, other]. The dispatcher was asked to collect the name and telephone number of the caller and any additional comments worth noting. On a monthly basis, these reports were photocopied and forwarded to the author for compilation on an Excel spreadsheet.

In many instances, there was more than one report generated for a particular wildlife sighting since several motorists would often call-in the same observation. In some instances it was difficult to separate sightings that originated from a specific location and time period. To address this problem, a period of one hour was required to have elapsed between sightings in the same location for them to be treated as separate observations in the analyses of reports.

Emergency Response Plan - As part of the project design, it was considered important to develop an emergency response strategy in the event that a moose became trapped within the electric fenced zone or some other public emergency associated with the fence. Officials from New Brunswick

DNR, DOT, RCMP and the Village of Belledune developed an emergency response protocol for this project [Figure 8]. In addition, ... from the Village of Belledune agreed to regularly monitor the fence for damage, vandalism, and respond to the alarm system when power outages or surges were detected.

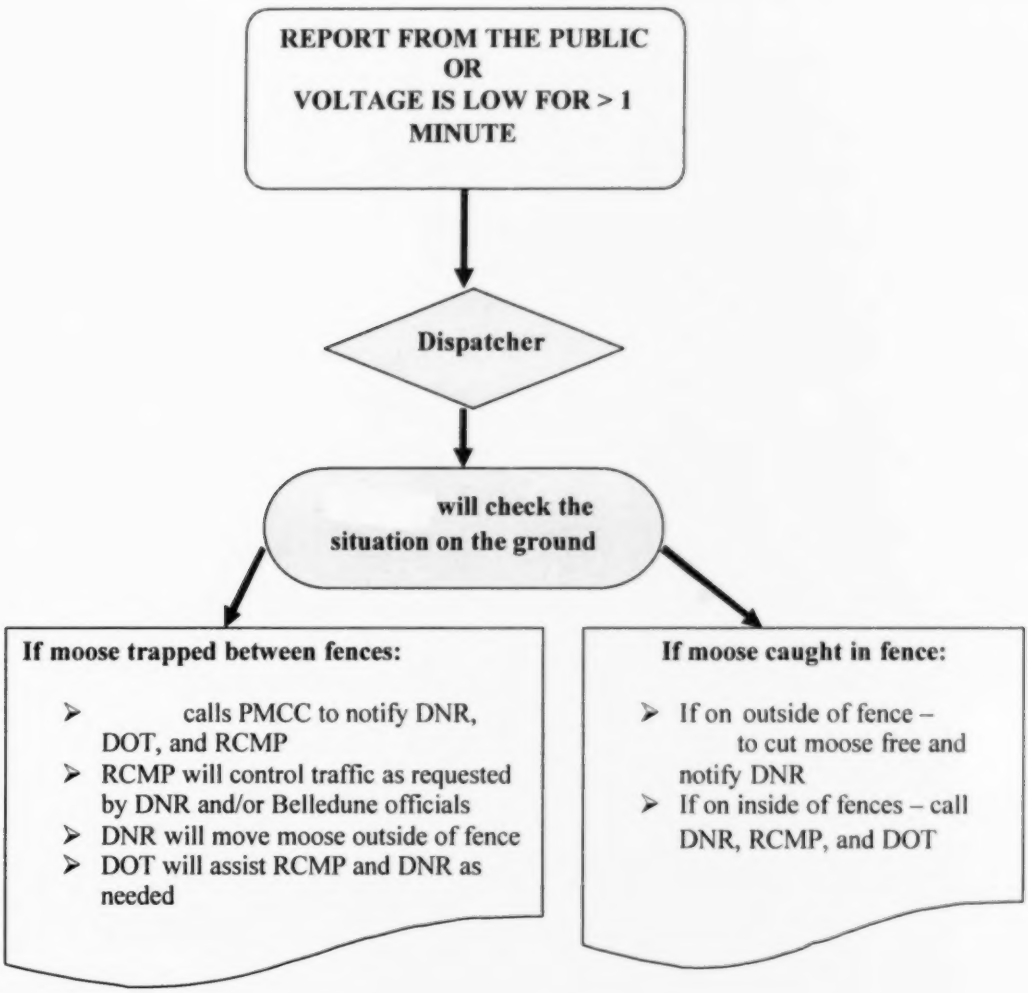

Figure 8. Emergency response protocol developed for the electric fence study, Route 11, Belledune, NB

ELECTRIC FENCE STUDY: EXPENDITURES

In this section of the report, expenditures are presented that were associated with the planning, construction, installation, and maintenance of this project through to the end of December 2003. In some instances, precise dollar figures were difficult to determine and thus estimated costs were projected. Maintenance and repairs to the fence varied from year-to-year depending upon problems or circumstances encountered.

Under the supervision of technical representatives from ElectroBraid Fence Limited, Halifax, approximately 10 km of 4-strand electric fence was erected during a 3-week period beginning in August 2000 [Figures 9 a, b, c, d]. [Note that a fifth strand was added in 2002 to deter animals from squeezing under or between the fence lines]. The Village of Belledune arranged for a team of workers to assist during the three-week installation phase. Local suppliers and DOT loaned or rented some of the construction and safety equipment needed during construction. ElectroBraid Fence Limited provided all fencing materials, posts, technical advice, and some of the equipment and labour for this project.

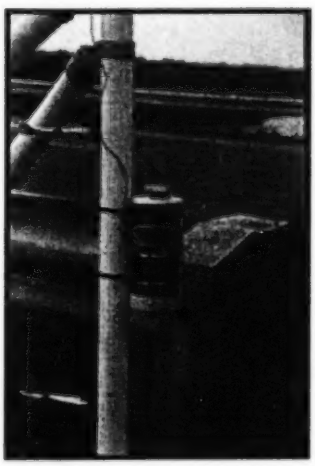

Figure 9a. End post tied-in to the guard rail at Belledune River, Route 11, NB. This was intended to reduce the chance of a moose accidentally entering between the fences. Voltage regulator is shown and power is connected to the fence on the other side of the highway through a culvert.

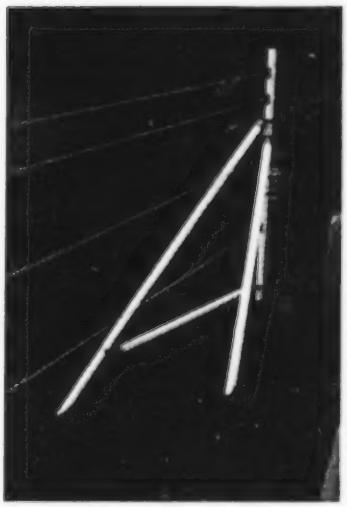

Figure 9 b. End post of moose fence installed next to the highway guard rail, Belledune River, Route 11, NB.

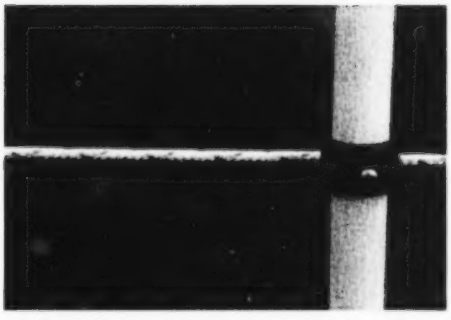

Figure 9 c. Close-up of the ElectroBraid wire and attachment to a post.

Figure 9 d. Example of how the ElectroBraid moose fence was installed along the highway shoulder of Route 11, near Belledune, NB.

The total financial expenditures of the moose fence for the period July 2000 through December 2003 were estimated to be $ 144,035. Table 1 summarizes the time and financial costs of the various components of the ElectroBraid fence project.

Several agencies, groups and individuals contributed their personal or staff time throughout the project. Periodic vegetation control on a 2 to 3 year cycle was projected to cost approximately $10,000 for both sides of the 17.5 kilometer control and fence area [Table 1].

ElectroBraid Fence Limited partnered in the project by providing, at cost, enough braid for 10 kilometers of fence, posts, and other fence materials needed for the project. In addition, the company supervised the installation, and assisted with maintenance and problem-solving for the duration of the project. Representatives from ElectroBraid Fence Limited actively participated in the Working Group and traveled to New Brunswick to participate in periodic meetings. The fencing materials represented approximately $ 50,000 of the project [Table 1] for which DOT reimbursed the company over the three year experimental project period.

DOT made other significant contributions to this project including supplying and erecting kilometer markers, purchasing, constructing and erecting highway signs, assisting with fence installation, as well as taking a lead role in the Working Group deliberations. These components for the fence project comprised an additional $ 31,000 of the overall cost of the study [Table 1].

Other financial contributors included the New Brunswick DNR which paid for one large highway sign [$10,000]. Staff monitored wildlife activity around the fence, and responded to wildlife

Table 1. Estimated financial and time expenditures associated with the planning, construction, installation, maintenance, and monitoring of the electric moose fence study for the period July 2000 through December 2003, Belledune, NB.

ITEM OR ACTIVITY	RESPONSIBILITY OR PARTNER	COSTS Actual or Estimated [e]
Vegetation Control – 15 km, both sides of highway prior and during fence installation [July-Sept. 2000].	ElectroBraid Fence Limited Village of Belledune	$ 9,575
ElectroBraid Fence – 5 km, both sides of highway; materials; posts; equipment; training; installation; supervision.	DOT [fence and materials] ElectroBraid Fence Limited	$ 50,000 (over 3 years)
Kilometer Markers – 16 markers with posts; installation	DOT	$ 1,500
Highway Signs – 2 signs with posts and installation	DOT, DNR	$ 20,000
Telephone Connections – alarm connection for fence; moose observation line; installation and monthly charges [$113.18 x 40 months]	Aliant [NB Tel]	$ 4,610
Electricity Connection – equipment, labour, [$ 4000.00], monthly energy charges [$7.50 x 40 months]	NB Power	$ 4,300
Monitoring and Assessment- ➢ 24hr/7 days per week recording of moose sightings	Belledune Dispatch Service	1218 person days
➢ Weekly checking of maze entrances [April – November = 27 checks]	Bathurst DNR	1.5 person days (e)
➢ Project monitoring: compilation, analyses, reporting [10 days/yr]	Maritime College of Forest Technology DOT	32 person days (e)
➢ Recording and compiling moose-vehicle collisions between Campbellton and Miramichi [2 days/yr]	Bathurst & Miramichi DNR DOT	7 person days (e)
➢ Progress meetings	Working Group	20 person days (e)
Fence Installation Expenses – Labour, compressor, generator, farm tractor, safety vehicles and signage, 1 ton truck, sand for maze [volunteers & loans]	Village of Belledune, Atlantic Rentals Bathurst, ElectoBraid Fence Ltd., DOT	$ 7050 (e)
Public Awareness - advertising, pamphlets, brochures, PSA's, video, etc.	DPS, Belledune Regional Environmental Association, DNR, DOT	$ 46,000 (e) [over 2 years]
Miscellaneous – ➢ Response to power outages and alarms ➢ Emergency response to trapped or dead moose ➢ Vandalism, lightning damage, materials	, Village of Belledune Bathurst DNR ElectroBraid Fence Ltd.	15 person days (e) 2 person days (e) $ 1,000
TOTAL ESTIMATED COSTS:	**Financial and time expenditure**	**$ 144,035 + 1295 person days**

incidents associated with the fence. Also DNR took a lead role in the annual public awareness campaigns, responded to media inquiries about the project, and regularly participated in Working Group meetings.

The New Brunswick Department of Public Safety [DPS] became actively involved in the project during the second year of the study. They made significant contributions to the project by developing a public safety video, poster, fact-sheet and pamphlet on moose-vehicle collisions in New Brunswick and producing and distributing several thousand copies throughout the Province. The Belledune Regional Environment Association [BREA] initiated local awareness of the project and alerted residents to the dangers of moose along the Route 11 highway corridor. Total financial contributions associated with public safety and awareness were estimated to be $ 46,000 [Table 1].

Aliant NB [formerly NB Tel] agreed to partner on this project by providing a dedicated telephone line for recording moose reports and waiving monthly service charges for the duration of the project. Monthly charges were approximately $115.25 per month for a total estimated contribution of $ 4,610 [Table 1].

New Brunswick Power was also a partner in this project by donating equipment and labour for connecting the electric fence to the provincial power grid. Monthly electricity charges [approximately $7.50] were waived, for a total contribution of $ 4,300 for the 40-month duration of the project [Table 1].

In addition to direct financial contributions, there were a multitude of organizations and individuals who contributed time and out-of-pocket expenses for this project to occur. Monitoring, assessment, emergency response, collating information, and attending meetings comprised a significant amount of personal and staff time. It was estimated that in excess of 1295 person days [including 24 hour/7 day per week availability by the Belledune Dispatch Service for recording moose reports] were contributed to this project [Table 1].

The Belledune Dispatch Service as well as residents and representatives from the Village of Belledune [particularly made significant time commitments to the coordination and monitoring of this study. Other significant contributors to this project included Working Group members as private individuals or representing organizations or agencies. The names, affiliations, and contact information for persons involved in the Northeast Moose-Vehicle Collision Working Group are presented in Appendix I.

ELECTRIC FENCE STUDY: RESULTS

REPORTS WITHIN THE MOOSE STUDY ZONE

Wildlife-Vehicle Collisions - During the 5-year period prior to fence installation, there were 0 to 7 collisions with moose or deer reported per year within the experimental fence zone [Table 2]. Along both the east and west control zones there were 0 to 5 wildlife–related collisions per year recorded during the same time period. Between 1996 and 2000, a total of 26 moose and four deer-vehicle collisions were reported along the Route 11 corridor that encompassed the fence zone and two control sections of highway, a total distance of 17.5 km [Table 2].

Table 2. Reported vehicle collisions involving moose and deer along the west and east control zones and the experimental electric fence zone, Route 11, New Brunswick, 1996 – 2003.

Year	Control Zones			Experimental Fence Zone	Total Accidents	Accidents by Species:	
	West	East	Total			Moose	Deer
1996	2	3	**5**	**2**	7	6	1
1997	0	0	**0**	**1**	1	0	1
1998	2	1	**3**	**5**	8	8	0
1999	1	3	**4**	**7**	11	10	1
2000	1	2	**3**	**0**	3	2	1
2001	*1*	*2*	*3*	*0*	*3*	*2*	*1*
2002	*1*	*1*	*2*	*1*	*3*	*2*	*1*
2003	*0*	*1*	*1*	*0*	*1*	*1*	*0*
Total	8	13	**21**	**16**	37	31	6

Although it appeared that the fenced section of highway had been somewhat of a "hotspot" for wildlife-vehicle collisions prior to the initiation of this study, the median number of wildlife-vehicle collisions per year for the west control, east control, and fence sections of Route 11 were quite similar for the period 1996 – 2000 [1, 2, and 2, respectively; Table 2]. There were not any statistical

differences detected in median yearly collision rates among the three sections of highway prior to initiation of the electric fence study [p>0.10; Kruskal-Wallis ANOVA].

The number of collisions per highway kilometer per year recorded for both control zones combined, ranged from 0 to 0.5 [Median=0.3] between 1996 and 2000; whereas within the fenced zone, the wildlife collision rate ranged from 0 to 1.4 per kilometer [Median=0.4] over the same 5-year period [Table 3]. Again, there were not any statistical differences in wildlife collision rates between the control zones and fenced zone prior to the ElectroBraid fence study [p>0.10; Mann-Whitney test]. The fenced zone appeared to exhibit more variation in year-to-year collision rates [0 to 7 /yr] than the two control zones [0 to 3 /yr] [Table 2] but statistical differences were not detected between the control and fence zones.

Table 3. Median and mean vehicle collisions [per km per year[1]] involving moose and deer in the two control zones [combined] and experimental electric fence zone for the 5-year period ***prior to*** the fence installation [1996-2000] and the 3-year period ***following*** the fence installation [2001-2003], Route 11, New Brunswick.

Period	Control Zones		Fenced Zone	
	Median	**Mean**	**Median**	**Mean**
1996 - 2000	**0.3**	0.3	**0.4**	0.6
2001 - 2003	**0.2**	0.2	**0.0**	0.1

[1] East and west control zones and fenced zone were each approximately 6km in length.

During the three years [2001-2003] that the electric fence was operating there was one moose-vehicle collision within the fence zone, two moose/deer collisions in the west control zone, and four reported in the east control section [Table 2]. The median collision rate in both control zones was one [1] per year and zero [0] per year for the fenced section of the study area [Table 2]. The median yearly

collision rate among the three sections of highway were not statistically different during the 3-year study [p>0.10; Kruskal-Wallis ANOVA].

Combining data from the two control zones, the median moose/deer-collision rate was 0.2 animals per kilometer per year during the study, 2001 to 2003 [Range= 0.1 to 0.3; Table 3]. Prior to this study [1996-2000], the median annual rate for the control zones was 0.3 collisions per kilometer.

Within the fenced section, there were no wildlife-vehicle collisions reported in 2001 or 2003, but one moose-truck collision was recorded in 2002 resulting in a median annual collision rate of zero [Table 3]. Prior to the study, the median collision rate within the fence zone was 0.4 moose-deer per kilometer per year.

Following three years of monitoring, 2001 through 2003, the median collision rate for the control zones [0.2 moose-deer/km] was not statistically different from the fence zone [0.0 moose/km] [p>0.10; Mann-Whitney test; Table 3]. The relatively short monitoring period of 3 years and high moose-vehicle collision variability prior to this study may have contributed to the lack of significantly detectable differences in collision rates between the control and fenced sections of Route 11.

Sightings of Moose, Deer, and Bear - A total of 489 reports were received of moose, deer, and black bear activity within the control and fenced zones during the 3-year study. These reports represented individual observations of moose or other wildlife. The median number of reports received each year was 150 [Mean= 163] and the overall median reporting rate was 9 animals per km/year [Table 4]. The total number of sightings declined

from 201 in 2001, 150 in 2002, to 138 reports received in 2003. Ninety-four percent [458] of all reports were for moose, 3.5 percent [17] were deer, and 2.5 percent [14] were bear. Thus, a median of 8 moose reports per km/yr occurred within the study area boundaries [Table 4].

Table 4. Sightings of moose, deer, and black bear along the west and east control zones and experimental electric fence zone, Route 11, New Brunswick, 2001 – 2003.

Year	Control Zones			Experimental Zone	Total Sightings	Sightings by Species		
	West	East	Total			Moose	Deer	Bear
2001	49	137	186	*15*	**201**	182	7	12
2002	30	95	125	*25*	**150**	141	8	1
2003	24	101	125	*13*	**138**	135	2	1
Totals	103	333	436	*53*	**489**	458	17	14
Median	**30**	**101**		*15*	**150**	141		
Mean	34	111		*18*	**163**	153		
Median/km/yr[1]	**5**	**16**		*3*	**9**	**8**		

[1] West Control, East Control, and Electric Fence zones were approximately 6km, 6.5km, and 5km in length, respectively for a total of 17.5km

The number of wildlife reports within the fenced zone varied from 13 to 25 per year for a total of 53 reports over the 3-year study [Median=15; Table 4]. In contrast, the west control zone had a total of 103 reports ranging from 25 to 49 per year [Median=30] and the east control zone generated the highest number of reports [333] ranging from 95 to 137 per year [Median=101; Table 4].

On a per kilometer basis, the median number of moose, deer, and bear sightings per year were 5 and 16 for the west and east control zones, respectively, whereas the fence zone had only 3 sightings per kilometer annually [Table 4]. There was a statistical difference in the median number of moose/deer/bear reports received for the three highway sections with the fenced zone reporting the lowest number of sightings [M=15] per year, followed by the west control section [M=30], then the east control section [M=101] [$p<0.01$; Kruskal-Wallis ANOVA].

Problems Associated with the Electric Fence - During the study, a record of all problems attributed to the fence were documented. These included minor issues such as the fence alarm being activated to more serious incidents of moose, deer, or black bear breaching the fence and entering Route 11 corridor. Other types of problems that were encountered between 19 September 2000 and December 2003 included trees falling on the fence, a lightning strike that destroyed a small section of the fence, and a large section of ElectroBraid wire stolen by thieves. The Fence Minder remote monitoring system that was installed for the electric fence was upgraded to provide continuous remote monitoring of fence voltage. When voltage dropped for any reason, such as trees falling on the fence, vandalism, or a moose getting caught in the fence, then the power was automatically turned off to avoid further shocks and the local repair technician [Joe Noel] was immediately contacted by internet and phone to take corrective action. A chronological summary of all of the problems associated with the fence during the study is presented in Table 5.

A total of twelve moose-related incidents were reported within the fence zone during this 3-year study. These involved moose being temporarily tangled in the fence wire or actually observed breaching the fence or seen between the two fences [Table 5]. There were three reports of deer either jumping the fence or observed between the two fence lines. Based on track evidence, there was one incident of a black bear that crossed the fence. From track evidence, it appeared that the electric fence was not a barrier to movement of smaller animals such as fox and coyotes. To minimize the chance of large animals such as moose, deer and bear breaching the fence by crawling under the wire, the fence was periodically inspected and the bottom wires adjusted to reduce gaps that were observed. During June 2002, a fifth strand of braid was added to the fence to prevent breaching by moose and deer.

Protocols were put in place to ensure that the bottom strand of braid were not higher than 24 inches [60 cm] above ground in any location.

Table 5. Reports of wildlife that breached the electric fence and other fence-associated problems, Route 11, Belledune, New Brunswick, September 2000 – December 2003.

Year[1]	Month	Species	Incident
2000	Oct.	**Moose**	8 Oct.; Antlers tangled in upper 3 strands of fence; power shut off and moose released unharmed
	Oct.	**Moose**	16 Oct.; Visual report of moose spotted between the 2 fences; line post was down in the area.
	Oct.	**Moose**	18 Oct.; Cow moose seen jumping fence and hind legs temporarily tangled; calf on the other side of highway calling.
	Nov.	-	Fence alarm activated: 18, 21, 24 November
	Dec.	Deer	Jumped over the fence then back behind the fence.
	Dec.	Bear	4 Dec.; tracks indicated that a bear crossed fence without hesitation; fox and coyotes appear to have no difficulty crossing fence from track evidence
	Dec.	-	Fence alarm activated: 12, 17, 31 December
2001	Jan.	-	Fence alarm activated: 02 and 24 January.
	Sept.	**Moose**	19 Sept.; crossed road in front of vehicle
2002	April	**Moose**	26 April; between 2 fences; walked through snowmobile crossing, crossed Route 11 exiting opening on other side; side-arms [maze] was down for winter.
	June	**Moose**	6 June; 1 calf crossed Rte 11 in front of car; Went through fence by lifting wire with its head.
	June	**Moose**	10 June; ran onto Rte 11 between fences.
	June	Deer	30 June; between 2 fences
	Aug.	-	Lightning strike destroyed approximately 100 ft of fence
	Aug.	-	Vandals removed approximately 1000 metres of braid on a section of fence, without setting off alarm.
	Sept.	**Moose**	Breached fence by lifting braid and catching it on the top post clip, leaving a gap for animal to get through; clip has been redesigned to prevent this in future.
	Sept	**Moose**	Injured moose on hwy [euthanized and removed by DNR]; 1km east of Belledune R.; hit by transport truck; no report to dispatch; no evidence of breached fence.
	Oct.	**Moose**	Went between the two bottom wires of the fence
2003	May	**Moose**	4 May; One moose between fences and one behind fence.
	Aug.	**Moose**	11 Aug.; Crossed highway and went behind the fence
	Sept.	Deer	10 Sept.; 2 deer on Rte. 11 between fences.
	Nov.	-	14 Nov.; tree fell on fence and sparks seen.
		-	17 Nov.; tree fell on fence.
		-	29 Nov.; tree fell on fence and fence down.

[1]Power was established to Electrobraid fence on 19 September 2000.

The first major problem occurred 8 October 2000 when a bull moose was reported trapped on the outside of the fence. The moose's antlers were tangled in the upper three strands of the electric braid [Figure 10]. Several vehicles had stopped to observe the animal before DNR and the RCMP arrived at the site. During this time, an unidentified trucker approached the trapped moose with an axe, intending to cut the braid to release the animal. However, the moose charged the "would-be good Samaritan" who was nearly injured [Figure 11]. It was reported that the moose tore the trousers of the trucker who was attempting to release the animal. In spite of the charge and agitation of the adult bull moose tangled in the fence, the animal was not able to break the ElectoBraid wire or significantly damage the fence posts. There was sufficient "play" in the fence braid and posts to absorb the thrashing of the moose. In addition, it did not appear that the moose was being shocked by the live wires of the fence, perhaps because the animal was caught by the antlers which would not readily conduct electrical current. Eventually the power to the fence was temporarily disconnected and the moose released unharmed by cutting the top three strands of fencing material. During this incident, a minor traffic accident occurred on the highway as a result of numerous vehicles that had stopped to observe the moose and activity.

Most of the problems associated with moose in this study occurred during late spring or early autumn. Spring is an active time for moose because of movements from winter to summer range. Pregnant cows actively search out suitable habitat to give birth in late May and often drive away their previous year's calves immediately prior to parturition. These abandoned yearling moose sometimes wander onto highways and near human habitation as they search for new habitats. Highway corridors also may be attractive to moose because of the salts and minerals that pool in ditches and the fresh, green, vegetation that emerges along roadside shoulders. In mid to late-May, highway corridors may

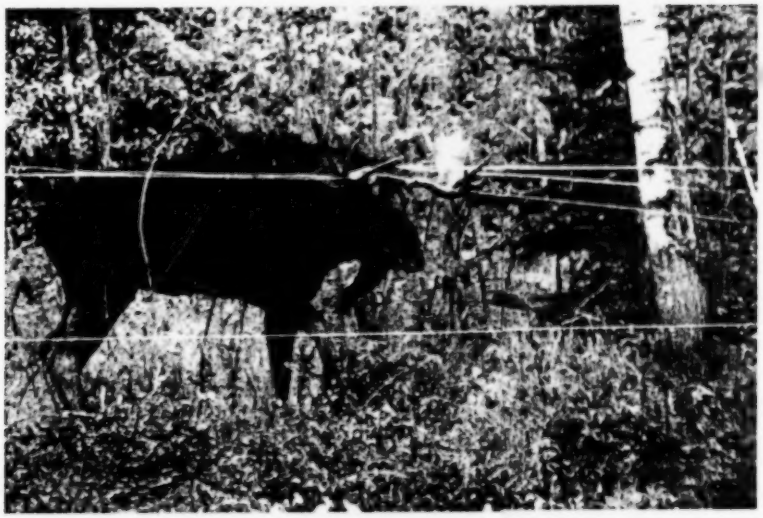

Figure 10. Bull moose caught by the antlers in the upper 3 strands of the electric fence, 8 October 2000, Route 11, near Belledune, NB.

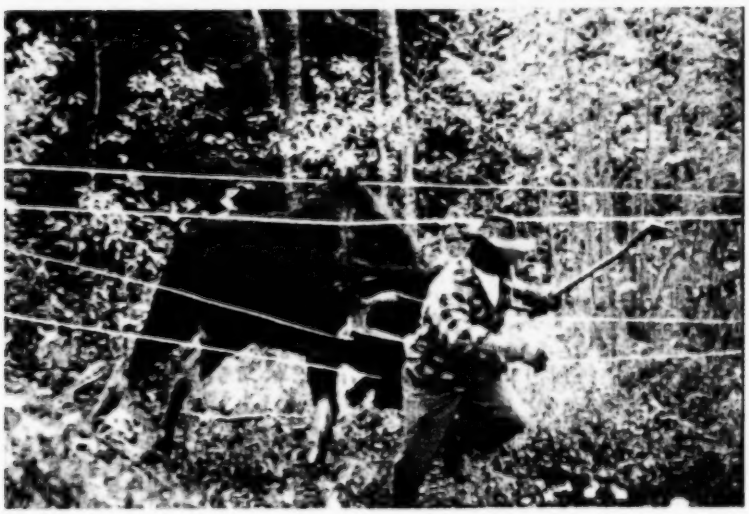

Figure 11. An unidentified trucker was charged by an adult bull moose as he was Attempting to use his axe to extricate the animal from the electric fence, 8 October 2000, Route 11, near Belledune NB.

offer respite from biting insects that emerge in full force during this time of year. Fall is another active time for moose with the onset of breeding [rut] in mid-September. Activities associated with hunting seasons will also initiate moose movements during September and October. In late fall, moose in the Belledune region may move out of the area to more suitable winter habitats.

In this study, the autumn occurrences included three incidents in October 2000, one in September 2001, and three in September and October 2002 [Table 5]. Four of the remaining five moose incidents occurred in spring [April through June] with one reported in mid-August 2003 [Table 5].

An incident on 26 April 2002 [Table 5] resulted in a moose crossing Route 11 by walking through the ATV-snowmobile access. During that winter, the side-arms of the maze had been adjusted to permit easier access for a snowmobile trail-grooming machine. The maze had not been realigned soon enough in 2002 resulting in a moose being able to easily cross the highway at that location. This led to ElectroBraid Fence Limited developing an electric mat [ElectroMAT] that can be laid flat on the ground to prevent access by moose and deer. Field trials of this mat to deter deer and elk are being conducted at the National Wildlife Research Center in Sandusky, Ohio, and by the Arizona Department of Fish and Game. ElectroBraid Fence Limited intends to install the ElectroMAT on both sides of the ATV crossing to prevent further breaches of the maze system.

During June of 2002 there were two reported incidents involving moose. On 6 June a calf was observed crossing the highway and went through the fence by lifting the wire with its head. Then on 10 June there was a report of a moose that ran onto Route 11 between the two fences.

In September of 2002 a moose was observed breaching the electric fence by lifting the braid and inadvertently hooking the wire on the top fence post. This left a gap for the animal to penetrate the fence and enter the highway corridor. The fence clips were later redesigned and replaced to prevent this from happening in future. It also was found that snow sometimes crusted on the lower strands of the electric fence braid causing some line post clips to break. Accordingly, the line post clips were re-engineered by ElectroBraid Fence Limited and are now triple their original strength.

Also in September, an injured moose was observed on the highway one kilometer east of the Belledune River. It appeared to have been hit by a transport truck but no report was received by the dispatch service. Following ground investigation, it was suspected that the animal may have either breached the fence through the 3rd and 4th strands or possibly entered the fenced corridor from the highway at the Belledune River. The animal was euthanized and removed by DNR. The final incident reported in October 2002 involved a moose breaching the fence between the two bottom wires [Table 5].

In 2003, there were two moose-related incidents reported; one in May identified a moose between the fences; another in August indicated that a moose crossed the highway and went behind the fence. In November there were three occasions when the fence alarm system activated because of trees that fell across the fencing [Table 5].

Detection of Mileage Markers - Prior to initiation of this study, the Working Group discussed the importance of providing motorists with some clear reference points to identify locations of wildlife sightings. Precise locations of moose sightings were considered crucial for assessing this project. Mileage [kilometer] markers along the highway were deemed to be a good mechanism for pinpointing locations of wildlife observed within the study area. Department of Transportation personnel installed mileage markers along Route 11 at each kilometer to assist with this aspect of the experimental electric fence study.

Within the fenced corridor and two control zones, the proportion of reports that included a reference to a mileage marker increased from 17 percent [2001] to 25 percent [2002], and 29 percent [2003] [Figure 12]. The overall number of reports declined from 201 in 2001 to 143 in 2003. Although references to kilometer markers on sighting reports was not common at the beginning of this study, it appeared that motorists gradually became more familiar with these signs and included them more frequently in their sighting reports during subsequent years.

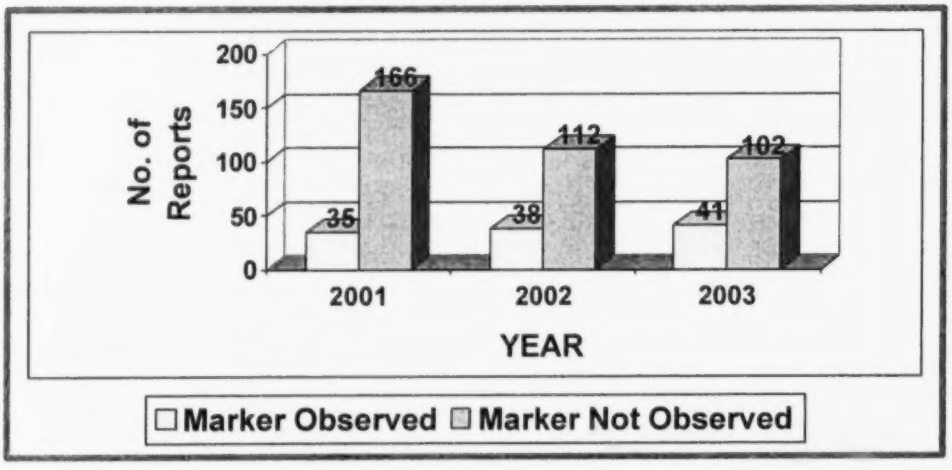

Figure 12. Number of reports when mileage [kilometer] markers were observed or not observed within the fenced and control zones along Route 11, near Belledune, New Brunswick, 2001 - 2003 [N=494].

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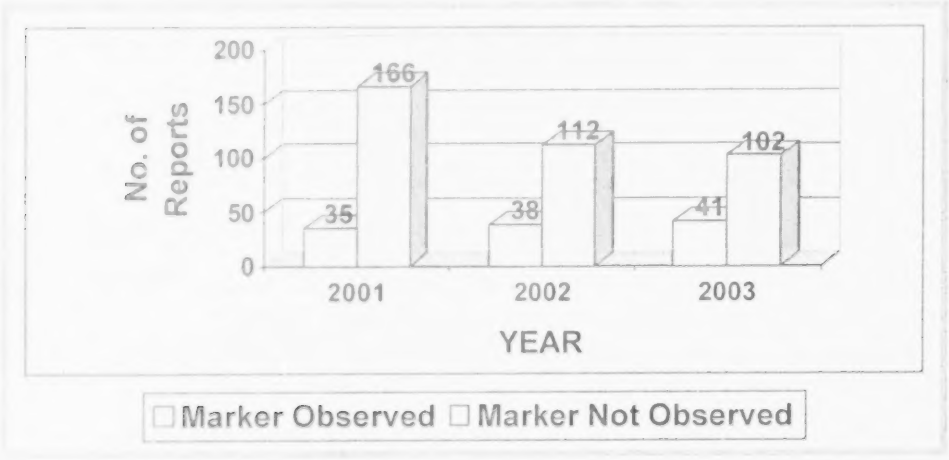

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OBSERVATIONS FROM ALL REPORTS

The following observations and results were based upon all reports received during the 3-year study. These include information from sightings both within and outside of the study area. A majority of the reports originated from observations along the Route 11 corridor from Miramichi City north to Campbellton. A few reports were recorded from other areas of New Brunswick and the Quebec region. Some of the reports used in the following analyses were multiple observations of the same animal[s] reported by different motorists.

Reporting Rate by the Motoring Public - A large "unknown" at the beginning of this project was to what extent motorists would cooperate and report moose and other wildlife sightings to the Belledune Dispatch Service via the dedicated telephone line. The overall success of this project was predicated upon the motoring public reporting all or most observations of moose, particularly within the two control zones and fenced section of Route 11. The project design included contacting local media in northeast New Brunswick to inform the public of this project and to solicit their participation during the 3-year study. The author and others of the Working Group were interviewed numerous times by media, prior to and during the project. This helped to maintain interest by the public and ensured that most sightings of moose and other wildlife were promptly reported.

Between July 2000 and December 2003 there were 1345 wildlife-related reports received by the Belledune Dispatch Service. Eighty-six percent [1156] of all reports were for observations along Route

11 [Figure 13]. Highway Routes 8 and 134 accounted for 78 and 53 reports, respectively. Unknown route numbers and other highways accounted for the remaining 58 observations [Figure 13].

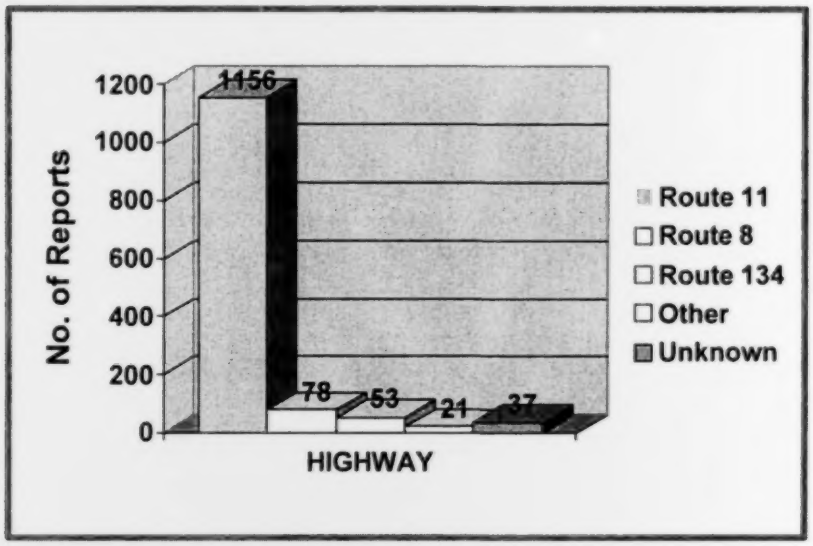

Figure 13. Moose and other wildlife-related activity [N=1345] reported for various highways in northeast New Brunswick for the period July 2000 through December 2003.

The first moose observation reported during the electric fence study period was recorded on 12 July 2000. A moose was reported standing on Route 8 immediately south of Bathurst city limits. During the remainder of 2000, only 13 moose observation reports were received from the public. The electric fence was not activated until 19 September 2000. This relatively low number of reports was not unexpected during the final few months of 2000. The large "Report Sightings" signs were not completed and erected until November 2000. Also, moose had previously been known to disperse out of the Belledune area during winter months.

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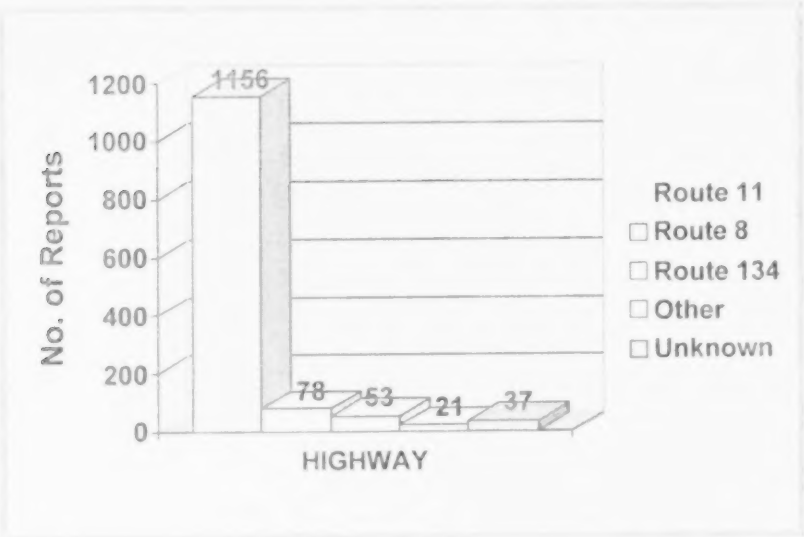

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A total of 1326 wildlife reports were received during the period 2001 through 2003 [Table 6]. An average of 442 reports were recorded each year; 471 in 2001, 403 in 2002, and 452 wildlife reports were documented in 2003. Nearly 37 percent of all reports [489] received represented wildlife sightings within either the control or experimental fence sections along Route 11. This response rate over the 3-year study exceeded the expectations of the Working Group and was considered sufficient for statistical analyses and assessment of the moose fence project.

Table 6. Reports received [N=1326] of moose and other wildlife activity by month during the three years [2001-2003] of the electric moose fence study, northeast New Brunswick.

	2001		2002		2003		Combined Years	
Month	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
January	**6**	1	**2**	0	**5**	1	**13**	1
February	**1**	0	**3**	1	**2**	0	**6**	0
March	**1**	0	**1**	0	**2**	0	**4**	0
April	**11**	2	**24**	6	**8**	2	**43**	3
May	**174**	37	**94**	23	**95**	21	**363**	27
June	**149**	32	**154**	38	**189**	42	**492**	37
July	**51**	11	**47**	12	**45**	10	**143**	11
August	**25**	5	**28**	7	**41**	9	**94**	7
September	**17**	4	**22**	6	**14**	3	**53**	4
October	**19**	4	**20**	5	**29**	6	**68**	5
November	**15**	3	**5**	1	**18**	4	**38**	3
December	**2**	0	**3**	1	**4**	1	**9**	1
TOTAL	**471**	99	**403**	100	**452**	99	**1326**	99

Wildlife Activity by Month - Wildlife reports were tallied by month for each year of the study to determine whether or not there was a pattern of activity among the three years [2001-2003]. Table 6 depicts the distribution of reports received by month during the study. A comparison of the distributions of reports by month among the three years

showed a very strong relationship in the annual monthly pattern of reporting [$p<0.005$; Kendall's Coefficient of Concordance W].

During each 12 month period, reports were few and sporadic from January through March. Beginning in April, the number of observations began to increase rapidly with the peak of observations [37%] occurring during the month of June each year. Seventy-five percent of all wildlife reports received [998/1326] were for the months of May, June and July each year. Observations gradually declined each month thereafter through to December [Table 6]. The four-month periods in the autumn [September – December] had higher wildlife reporting rates [13 percent of reports] than winter periods [January – April; 4 percent] each year [Table 6].

Wildlife Activity by Time of Day - Wildlife reports [2001-2003] were examined by time of day or night [over 24 hours] that observations were reported, to determine whether or not diurnal and/or nocturnal patterns of wildlife activity could be discerned during the study. From a motorist safety perspective, knowledge of the periods of day that wildlife were most active and prevalent along highway corridors would be useful for assessing collision risks.

Observations were categorized arbitrarily into two-hour blocks beginning at midnight for each year of the study [Table 7]. Distributions of wildlife observations over 24 hour periods showed very similar patterns of activity each year [$p<0.005$; Kendall's Coefficient of Concordance W]. Each year, only a few reports were received between midnight and 06:00 hours, but there was a marked increase in observations between 06:01 and 10:00 hours each day [Table 7]. Activity waned between 10:01 and

18:00 hours, but then there was a sharp increase in wildlife reports from 18:01 through 22:00 hours, representing 33 percent of daily observations. Wildlife activity reports were fairly low between 22:01 and midnight each day [Table 7]. Notably, the highest number of reports of wildlife activity occurred during the two-hour period between 8pm and 10pm [20:01 and 22:00 hours; Table 7].

Table 7. Time of day or night that moose and other wildlife activity were observed during the electric fence study, northeast New Brunswick, 2001-2003, N=1326.

Time of	**2001**		**2002**		**2003**		**Combined**	
Observation [hrs]	N	%	N	%	N	%	**Years**	**%**
Midnight - 0200	5	1	5	1	2	0	12	**1**
0201 – 0400	4	1	3	1	4	1	11	**1**
0401 - 0600	30	6	15	4	11	2	56	**4**
0601 – 0800	65	14	38	9	55	12	158	**12**
0801 – 1000	51	11	41	10	56	12	148	**11**
1001 – 1200	41	9	35	9	26	6	102	**8**
Noon – 1400	22	5	23	6	30	7	75	**6**
1401 – 1600	25	5	37	9	42	9	104	**8**
1601 – 1800	36	8	30	7	49	11	115	**9**
1801 – 2000	47	10	43	11	46	10	136	**10**
2001 – 2200	101	21	97	24	111	25	309	**23**
2201 - 2400	31	7	17	4	17	4	65	**5**
Unknown time	13	3	19	5	3	1	35	**3**
Total Observations	**471**	**100**	**403**	**100**	**452**	**100**	**1326**	**100**

It is prudent to note that vehicle traffic patterns probably influenced the reporting rate of wildlife activity during this study. Certainly, higher proportions of mid-day wildlife reports compared to late-night observations [Table 7] likely were affected by improved motorist visibility and higher traffic volumes during daylight hours. No attempts were made to document daily or seasonal changes in traffic volumes in this region. However, wildlife research has shown that animals such as moose and deer are usually most active at dawn and dusk periods each day. Wildlife observations documented in this study appeared to corroborate these findings.

Wildlife Species Reported - A variety of wildlife species other than moose were reported by motorists during this study. By far, moose were the most prevalent species observed representing 95 percent [1233] of all species reported [1296] [Figure 14]. In addition to deer and bear sightings there were a few reports received for coyote, raven and crow. There were several instances when both moose and deer or moose and bear were reported on the same sighting record. Occasionally, motorists would call the dedicated moose telephone line to report other events or to ask questions.

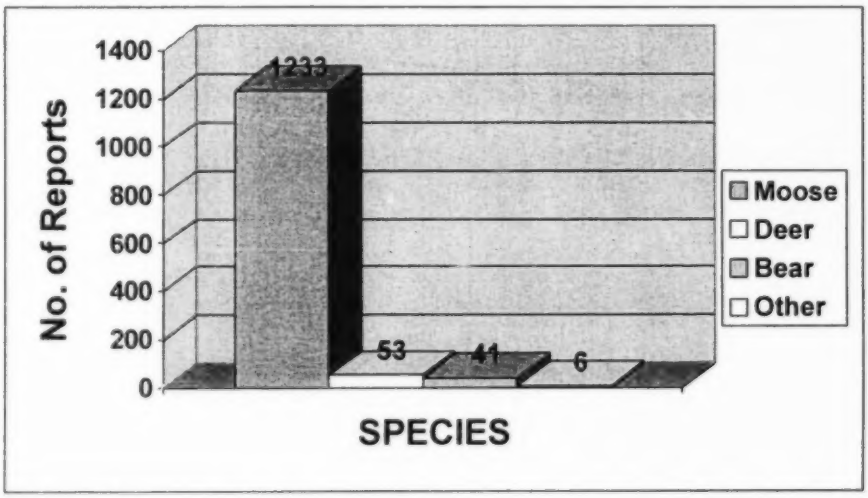
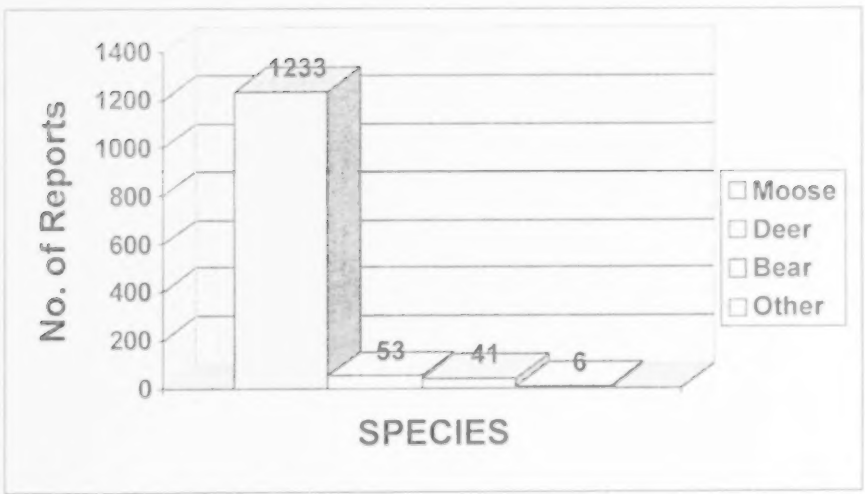


Figure 14. The number of moose and other wildlife species reported to the Belledune Dispatch Service from July 2000 through December 2003, northeast New Brunswick [N=1296].

Wildlife Behaviors Observed - The Working Group was interested in documenting the types of behaviors that wildlife exhibited when observed by motorists. Behavioral categories included: standing, walking, feeding, drinking, running, dead, and other/unknown. The "other" category included animals that appeared injured. In many instances, moose were exhibiting multiple behaviors when observed by passing motorists. The most frequent

Wildlife Species Reported - A variety of wildlife species other than moose were reported by motorists during this study. By far, moose were the most prevalent species observed representing 95 percent [1233] of all species reported [1296] [Figure 14]. In addition to deer and bear sightings there were a few reports received for coyote, raven and crow. There were several instances when both moose and deer or moose and bear were reported on the same sighting record. Occasionally, motorists would call the dedicated moose telephone line to report other events or to ask questions.



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behaviors reported were animals either standing or walking along or across the highway corridor [Figure 15]. Observations of animals feeding or running also were common. Although there were 66 records of animals reported dead, in almost all of these instances there were several reports for each mortality observed. One motorist reported seeing a moose trying to dig near or under the electric fence.

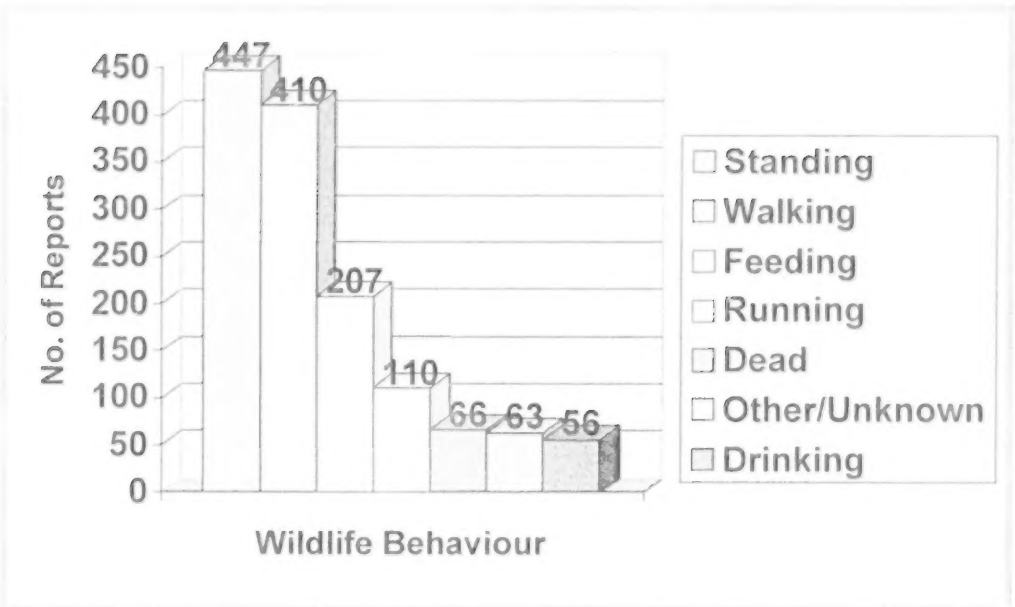

Figure 15. Observations [N=1359] of wildlife behaviors reported by motorists between July 2000 and December 2003, northeast New Brunswick.

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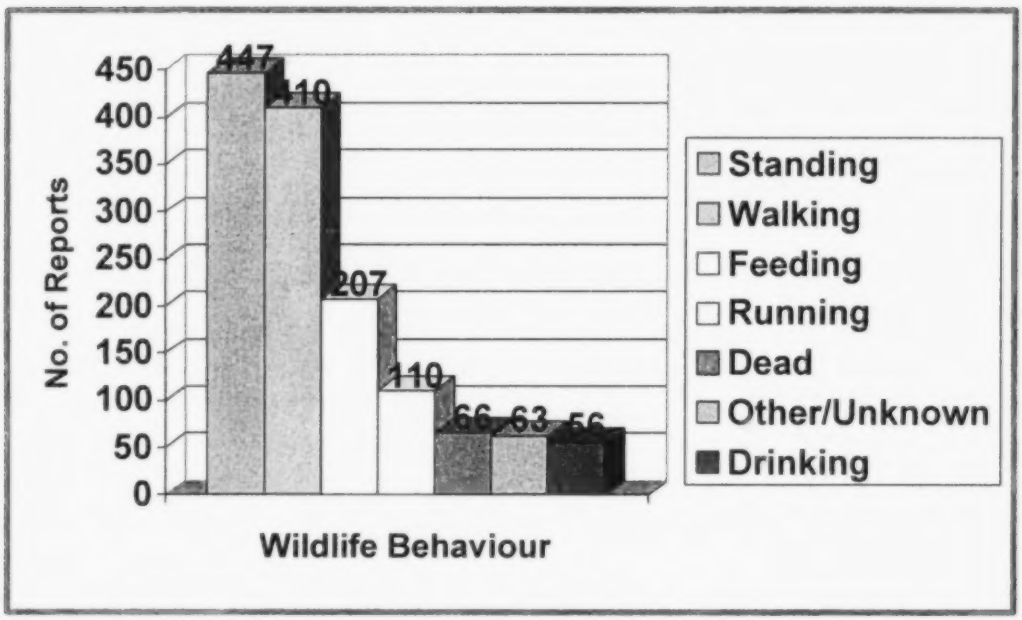

Figure 15. Observations [N=1359] of wildlife behaviors reported by motorists between July 2000 and December 2003, northeast New Brunswick.

Group Sizes of Moose Sightings - Another variable that was documented during this study was the number of moose observed together at each reported sighting. Larger group sizes probably would be more easily detected by motorists but could pose increased safety risks to the motoring public. For all moose reports [1232] documented from 2000 to 2003, the distribution of the number of animals observed together was summarized in Table 8 to determine whether or not there was a pattern of moose group sizes among years.

Table 8. Group sizes of all moose sightings [N=1232] reported during the electric fence study, northeastern New Brunswick, 2000 – 2003.

Group Size	2000	2001	2002	2003	Combined	%
1	5	284	263	323	**875**	71
2	3	109	83	82	**277**	23
3	2	32	15	14	**63**	5
4	0	5	1	5	**11**	1
5	0	1	0	2	**3**	0
6	0	0	0	1	**1**	0
Unknown	0	0	1	1	**2**	0
Total	10	431	363	428	**1232**	100

The distributions of moose group sizes were compared among the 3-year period, 2001 to 2003. Group sizes ranged from one to six moose each year with most sightings comprised of single moose [71%] or two moose together [23%; Table 8]. The patterns of group size distribution were very similar from year-to-year during this study [p=0.001; Kendall's Coefficient of Concordance W]. Ninety-four percent of all reports indicated one or two moose together at a time. Only one percent of all reports indicated moose group sizes of 4, 5, or 6 animals.

It was of interest to determine whether or not the pattern of moose group sizes showed similar distributions by month during this 3-year study. Did observations of single moose show the same

distribution from January through December as groups of two or three moose? Table 9 depicts the distributions of moose groups by month for the period 2001 to 2003 combined.

Table 9. Group sizes of all moose sightings [N=1225[1]] reported by month during the electric fence study, northeastern New Brunswick, 2000 – 2003.

Month	Size of Moose Groups						Total
	1	2	3	4	5	6	
January	7	4	0	0	0	0	11
February	2	2	2	0	0	0	6
March	3	0	0	0	0	0	3
April	31	6	1	0	0	0	38
May	215	89	27	4	0	0	335
June	357	87	20	6	2	0	472
July	92	30	4	1	0	1	128
August	55	22	2	0	0	0	79
September	33	8	2	0	1	0	44
October	44	16	3	0	0	0	63
November	29	2	0	0	0	0	31
December	7	5	3	0	0	0	15
Total	**875**	**271**	**64**	**11**	**3**	**1**	**1225**

[1] Represents all moose reported during the study, including repeated observations by different individuals of the same sightings.

The patterns of distribution by month for moose separated into groups of 1, 2, or 3 individuals were compared. Analyses showed that there was a strong relationship among the three moose group sizes for each month of the year [$p<0.005$; Kendall's Coefficient of Concordance W]. In other words, whether moose were alone or in groups of two or three individuals, their distribution pattern by month remained the same. May, June, and July appeared to be the peak period for moose observations, irrespective of group size.

PUBLIC AWARENESS PROGRAM

An integral part of the implementation of the electric fence project was to garner support and participation by motorists who traveled through the control zones and fenced corridor during the study. As previously mentioned, the reporting rate during this experiment was consistent and sufficient for analyzing the effectiveness of the fence. In several instances, members of the Working Group were contacted by various media for updates and information on the fence study. Interest by the public and media was considered quite high for the duration of the study.

Representatives from the Village of Belledune were particularly helpful in keeping the profile of this project in the public's mind through word of mouth and contact with various groups and media in the Belledune region. Whenever a serious moose-vehicle collision occurred within the Province, the media often contacted representatives of the Working Group for background or comments for their reports. Members of the Belledune Regional Environment Association [BREA] as well as Working Group members who resided in the Belledune area took a strong interest in the fence study, which greatly assisted in keeping the profile of the project in the public eye. By taking "ownership" of this project, members of the Belledune community and BREA helped to enhance the public's awareness of the study as well as reinforce the dangers of moose-vehicle collisions along Route 11.

Part way through the project [2002], the NB Department of Public Safety joined the Working Group on a regular basis to provide input and ideas on how to raise the awareness of motorists to the risks of moose-vehicle collisions along highways in New Brunswick. Department of Public Safety in conjunction with DOT and DNR provided guidance and financial resources to develop and distribute a bilingual brochure and poster entitled: "DANGER… Moose Alert… Slow Down, Stay Alert, Stay

Alive!" [Figure 16]. These brochures and posters were distributed to various government offices and tourist bureaus throughout New Brunswick to alert the motoring public of moose-vehicle collision risks. It outlined dangerous highway corridors, the timing of moose-vehicle collisions, and how to avoid collisions with wildlife while driving.

Figure 16. Depictions of the moose-vehicle collision awareness materials developed by the Department of Public Safety in conjunction with the Northeast New Brunswick Moose-Vehicle Collision Working Group during 2002.

In addition, a ten minute video was developed using the same title as on the brochure for use in public service announcements and driver training programs. The video explored in more detail the dangers of moose on highways and some strategies for avoiding collisions. With cooperation from URSUS Productions, Maine, USA and using video footage from New Brunswick and Maine, the script was designed and the video produced with the assistance of Communications New Brunswick. A limited number of these videos were produced for distribution in New Brunswick.

On 11 June 2002, a public safety education and awareness campaign aimed at reducing moose-vehicle collisions along New Brunswick highways was launched during a news conference in Belledune. Participants included Public Safety Minister Margaret-Ann Blaney, Transportation Minister Percy Mockler, Natural Resources Minister Jeannot Volpe, local civic officials, and members of the Northeast New Brunswick Moose-Vehicle Collision Working Group [Figure 17].

The campaign components included the airing of paid radio and television ads and the province-wide distribution of thousands of brochures and posters and an educational video to inform the motoring public about moose-vehicle collisions and what could be done to prevent highway collisions involving moose. The total campaign costs, paid for by the Department of Public Safety, for 2002-03 were approximately $32,000.

During 2003-04, the DPS spent $14,000 on public awareness initiatives that included two province-wide one-week radio ad campaigns [one in May and the other in August 2003]. In June, brochures and posters were distributed to all businesses along Route 7 between Fredericton and Saint John. As well, public service announcements were sent to all media outlets for broadcast or publishing.

Enforcement and public education efforts also were stepped-up by the RCMP along Routes 7, 8, and 11. Information [poster, pamphlet, fact sheet] was placed on the DPS website at ***http://www.gnb.ca/0113/moose/alert-e.asp***.

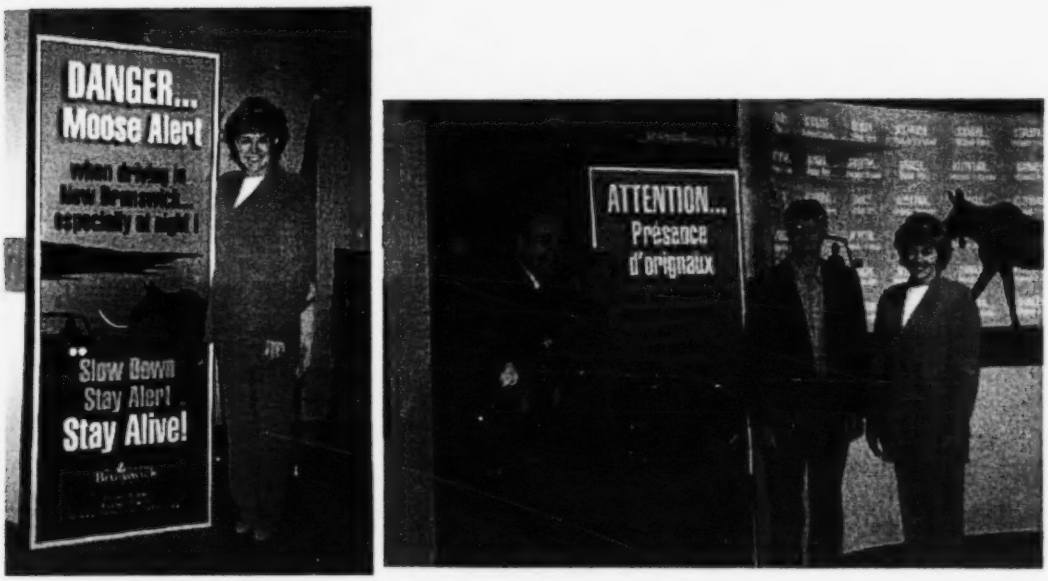

Figure 17. June 11, 2002 launch in Belledune of a public safety campaign designed to reduce moose-vehicle collisions along New Brunswick highways.

OBSERVATIONS, CONCLUSIONS AND RECOMMENDATIONS

The Northeast New Brunswick Moose-Vehicle Accident Working Group was satisfied that the three year study of the electric moose fence provided sufficient information and results to draw some conclusions with respect to the effectiveness of the fence to deter moose and other large animals from accessing the highway corridor. This study was set-up as an experiment which included appropriate "controls" to provide adequate statistical and scientific rigor for the results that were obtained.

The remainder of this report will focus on observations and conclusions generated from the key result areas associated with determining the effectiveness of the ElectroBraid electric fence in preventing moose-vehicle collisions. General recommendations on the operational use of electric and other wildlife fencing by transportation agencies are presented. In addition, suggestions for future research have been identified.

1. Participation by Motorists

The approach of relying upon the motoring public to provide useful and reliable information on moose and other wildlife observations within the study area proved to be adequate for analytical purposes. More than 1300 reports were received over three years with an average of 442 reports recorded annually. Sightings within the 15 km study zone along Route 11 exceeded 450 during 3 years of monitoring. This was considered very good participation by motorists traveling in the Belledune region. The number of reports exceeded 400 in every year of the study.

The high participation rate was attributed to several factors: (1) the signs erected at either end of the study area were large, visible, and displayed a short, simple message requesting the public's participation; (2) the prevalence of cellular telephones in private vehicles provided opportunities for prompt and nearly instantaneous participation by motorists who spotted moose or other wildlife along the highway corridor; (3) the ability to record information relayed by motorists at any time of day or night, 365 days per year, via the Belledune Dispatch Service ensured good quality of information received and minimized any loss of observations from motorists who could readily access telephones; (4) the consistent efforts throughout the 3-year project by various members of the Working Group to keep the profile of this project in the public eye by responding to and initiating media interviews, provided regular momentum and interest by the motoring public in the Belledune region.

2. Project Expenditures

The overall financial cost for implementing this 3-year study was approximately $144,000 and time expenditures exceeded 1,200 man-days. A wide variety of agencies and individuals contributed direct and/or in-kind financial or manpower support throughout the project. A significant proportion of the man-days for this study involved the 24 hour monitoring services provided by the Belledune Dispatch Service.

This project, in essence, was a field-experiment and thus incurred additional costs that would not occur by simply deploying and maintaining the electric fence along a stretch of highway. For example, signage and public awareness expenditures would not normally be incurred on an operational basis. The actual cost of the fence materials, installation, electricity, vegetation control,

and maintenance over the 3-years was approximately $75,000 for the five kilometers of ElectroBraid fencing deployed on both sides of Route 11. One-time expenditures for fence materials, installation [including volunteer and in-kind support], and connection to the power grid was approximately $61,000 or $12,200 per kilometer of fenced highway. Annual recurring costs [electricity, vegetation control, maintenance] were estimated to be approximately $4,000.00 or $800 per kilometer of fence [both sides of highway] per year. Most of these recurring expenditures were associated with periodic brushing back of vegetation along the fence line.

Standard non-electric wildlife fencing currently deployed in some parts of New Brunswick is estimated to cost $70,000 per kilometer plus annual maintenance for natural damage and vandalism. The electric fence appeared to be less costly to purchase and erect than regular wildlife fencing. It was unclear what the estimated annual maintenance costs were per kilometer for standard wildlife fencing, although damage from vandalism, fallen trees, erosion, and frost heave are likely substantial. Average maintenance costs for this study were estimated to be $800 per kilometer per year and costs were largely attributed to vegetation control measures.

3. Wildlife Sightings

Nearly 500 reports of moose, deer and bear sightings within the experimental zone along Route 11 were documented during the 3-year study. Moose sightings comprised nearly 95 percent of these reports.

The electric fence appeared to have had a significant influence in reducing the number of wildlife reports along the 5 km section of fenced highway. Indeed, the median reporting rate in the

fenced zone was only 3 sightings per kilometer per year compared to 5 and 16 per kilometer per year for the west and east control zones, respectively. The east control section of Route 11 showed substantially more wildlife activity than either the west control zone or the fenced section of the highway.

It must be kept in mind that during this 3-year study the fence itself had the obvious effect of deterring moose, deer and bear from being detected by passing motorists. Indeed, there may have been several instances within the fenced section when wildlife were present behind the fence but not detected by passing motorists. In other words, the field-of-view was different for motorists within the fence zone compared to the control zones where wildlife could move more freely and closer to the highway corridor.

4. Wildlife-Vehicle Accidents

During the 3 years that the fenced zone was monitored there was one moose-vehicle accident reported within the fenced zone. The moose was struck by a transport truck sometime prior to 03:00 hours in late September 2002, approximately one kilometer southeast of the fence entrance at the Belledune River. DNR personnel traveling in the area dispatched and removed the injured moose from the highway. The person who struck the moose never reported the incident to authorities or via the designated telephone line.

During the same 3-year monitoring period a total of 4 moose and 2 deer were reported killed along the two control sections of Route 11; two collisions on the West Control Zone and 4 collisions recorded along the East Control section. However, there was not sufficient evidence to

show a statistical drop in collision rates in either the control or fenced zones. The median number of collisions per kilometer per year dropped from 0.3 [1996-2000] to 0.2 [2001-2003] within the control zones and from 0.4 to less than 0.1 between the same time periods along the fenced section of Route 11. Prior to initiation of this project, there was considerable variability in reported collisions from year to year in the region of the study area. By monitoring the fence and control zones for a few more years, a statistically significant decline may become evident within the fence zone.

5. Overall Observations and Comments

It must be recognized that this project was the first application in North America of an electric fence specifically designed to deter moose along a linear highway system. It involved a relatively short section [5 km] of highway located along a highway corridor that did not require one-way gates or underpasses; structures that are typically incorporated into standard wildlife fencing in New Brunswick and other jurisdictions. Since the inception of this project, the Province of Quebec has embarked upon two similar electric fencing pilot studies within extensive moose habitat and highway corridors. In 2002, Quebec moved ahead with 10 kilometers of fencing, then added 20 kilometers more of electric fencing in 2004. Arizona installed a trial fence in 2004, and in 2005, ElectroBraid fencing was approved for highway projects in Arizona, New Mexico, Montana and Alaska, cost shared by the US Federal Highways Administration.

Although the electric fence in this study was not 100% effective in preventing moose from accessing Route 11, it did appear to provide substantial protection for motorists. Breaches did occur in each year of the 3-year study, but at least some of them were preventable. Careful

monitoring of the fence was invaluable for understanding and correcting some of the problems encountered during the project. Occasionally it was not possible to exactly identify how moose were able to enter the highway corridor nor to validate all of the incidents/observations of moose and other wildlife within the fence zone.

Moose with antlers sometimes lifted the fence braid to provide a gap to enter the highway, but adjustments were made to the top fence post clip to minimize these types of problems. On at least one occasion, a moose entered the highway because the ATV crossing maze was temporarily dismantled during the winter. This was rectified by redeploying the fence maze at the end of winter before moose began moving back to the area. Deer were reported between the fences on three occasions between October 2000 and December 2003. On one occasion, deer were seen actually jumping the fence.

The fence alarm system appeared to work well for the duration of the project. Reductions in voltage triggered the alarm on several occasions and usually it was possible to pin-point the problems fairly quickly. Factors such as lightning and fallen trees were responsible for most of the alarm occurrences. The one instance of vandalism where approximately 1000 metres of fence braid was stolen was the work of persons who knew the electrical components of the fence and were able to circumvent the alarm. Subsequently, modifications to the fence were employed to prevent large sections of braid from being easily removed.

GENERAL RECOMMENDATIONS

a) The study area [control and fence zones] should be monitored for an additional two years in order to provide a 5-year period to assess the effectiveness of the fence and better compare the collision rates to those documented between 1996 to 2000. High year-to-year variability with respect to accident rates prior to the study may have contributed o the lack of statistical significance detected during the 3-year monitoring period.

b) Transportation agencies that have moose within their jurisdictions should consider electric fencing for wildlife as one of their options for effective management of moose-vehicle collision risks. The portability, durability, low cost of materials and maintenance, and high effectiveness in deterring moose, make this fence an acceptable candidate for deploying along relatively short sections of highway that bisect high-density moose range. Electric wildlife fencing could be used for diverting or funneling moose away from dangerous sections of highway towards safer crossing points for both moose and motorists, such as underpasses or lighted sections of roadways.

c) Transportation and Natural Resource agencies should consider utilizing the opportunity of today's high prevalence of motorists with cellular phones in their vehicles, to monitor wildlife activity along highways within their jurisdictions. A toll-free telephone number that motorists could call to report roadway wildlife sightings would provide valuable insight into chronic or developing wildlife-vehicle collision problem areas. Moose, deer, and black bear populations are never static and numbers rise and decline for a variety of biological

and man-induced factors. Employing a long-term tracking system for wildlife sightings along highways could enable agencies to be pro-active in identifying dangerous sections of highway, thus allowing them to take pre-emptive action to minimize the chance of collisions from occurring.

d) Future studies of electric or other wildlife fencing material should consider deploying cameras to monitor behavior of moose, bear, deer and other wildlife that encounter fencing. This would provide more conclusive data on exactly how animals breach fences or whether or not they get onto highway corridors through the entrances at either end of the fence zone. This information could provide valuable insight for improving fence design and/or deployment.

e) Some other approaches and areas for research that could be explored to reduce wildlife-vehicle accidents include: (i) testing flashing warning signs along high-risk highway corridors that are activated/deactivated based upon real-time sightings by motorists; (ii) testing various intensities and types of highway lighting; (iii) providing AM or FM radio channels that motorists can monitor when driving that provides up-to-date reports of wildlife sightings along highways; (iv) determining the effectiveness and practicality of infrared technology for activating warning signals to drivers when wildlife is detected along highways; (v) providing a computer website that motorists can monitor prior to travel that alerts them to recent and historical sightings and collisions with wildlife along their route of travel; (v) implementing and monitoring reductions in night-time highway speeds along dangerous wildlife corridors; (vii) developing measures to determine the effectiveness of

public awareness programs in modifying driver behaviors and reducing wildlife-vehicle collisions, and (viii) ensure regular meetings with representatives of other jurisdictions or organizations to exchange research/management information on wildlife collision mitigation procedures that are being tested or used.

Collisions with moose, in particular, present challenges not only in New Brunswick, but also in Newfoundland, Maine, Quebec, and Ontario. Although all of these jurisdictions utilize standard highway signage and public awareness programs in efforts to reduce wildlife collisions, New Brunswick and Quebec have been the only provinces to date, that have experimented with electric fencing solutions. New Brunswick also has deployed customized highway signage with the objective of enhancing motorist's awareness of moose-collision risks along Route 7 between Fredericton and Saint John.

Reducing wildlife collisions will continue to be an ongoing challenge. North Americans currently are highly dependent on private motor vehicles for transportation. Generally, the quality of roads and highways have improved with corresponding increases in vehicle speeds and traffic volumes. Habitats for wildlife are changing as human development continues to encroach into wild lands. How can wildlife and motorists be protected from each other? Providing innovative and effective wildlife barriers such as electric or standard wildlife fencing as well as adapting communication technology to provide real-time information or warnings to motorists seems to be reasonable directions for further research and study.

This 3-year study demonstrated that electric wildlife fencing has the ***potential*** to reduce the number of moose-vehicle collisions, at least along a relatively short, dangerous section of highway in northeastern New Brunswick. A few more years of monitoring will be needed to substantiate this finding. The reader is cautioned that widespread deployment of electric wildlife fencing may actually be more costly than standard wildlife fencing over the long-term because of predicted higher ongoing maintenance requirements. In addition, electric wildlife fencing should only be considered for deployment on Level I access controlled highways where access issues are minimal.

In New Brunswick, the possibility exists for motorists to be involved in wildlife-vehicle collisions virtually anywhere. Drivers have the responsibility to recognize dangerous highway corridors and to significantly reduce their vehicle speeds and stay alert, particularly during low-light conditions. Public awareness initiatives should continue to play a significant role in addressing wildlife-vehicle collisions.

APPENDIX I

Names, affiliations, and contact information for 22 members of the Northeast New Brunswick Moose-Vehicle Collision Working Group.

NAME	AFFILIATION	EMAIL	PHONE
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	ElectroBraid Fence Ltd., Halifax		
	Village of Belledune		
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O'Neil, Robbie	NB Public Safety	Robbie.Oneil@gnb.ca	444.4574
Phillips, Mike	NB DOT Fredericton	Mike.Phillips@gnb.ca	453.2754
Redmond, Gerald	Maritime College of Forest Technology, Fredericton	gredmond@mcft.ca	458.5128 363.3115
	City of Bathurst		

APPENDIX II

Moose observation form used by the Belledune Dispatch Service to gather information about moose sightings reported by motorists along Route 11, Belledune, NB, 2000-2003.

Moose Observation Report Rept. # _____

- **Date of call:** _____ **Time of Call:** _____

Wildlife Observation

- **Date observed:** _____
- **Time observed:** _____ ☐ **am** ☐ **pm**
- **Route/Highway #** ____ **Mileage Marker #** _____

Precise Location: _____

_____

_____

Side of highway: ☐ **east** ☐ **west** ☐ **on hwy.**

☐ **within control zone** ☐ **within fence zone**

Type of Observation:

☐**moose** ☐**deer** ☐**bear** _____ **other**

Total number of animals: _____

#males: ___ **#females:** ___ **#unk. sex:** ___

Behaviour: ☐**walking** ☐**running**
☐**standing** ☐**feeding**

Other: _____

Caller Identification:

Name: _____

Telephone _____

Comments: